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PRODUCTION AND CHARACTERIZATION OF LOW THERMAL CONDUCTIVITY CLAY BRICKS BY ADMIXTURE OF BAGASSE AND PERLITE

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ABSTRACT

In this paper, an investigation on the reduction of thermal conductivity in clay-based construction materials is carried out. Clay is the basic material for brick production, bagasse and perlite were additive elements in clay, which is from sugar industrial waste i.e. Bagasse and perlite, which is from siliceous volcanic rock. Bagasse facilitates the porous nature in brick and perlite consists of rich amount of Al_2O_3 and SiO_2; while thermal insulation properties improve inclay-based construction materials.

Samples were prepared according to laboratory required dimensions of 150x100x50 mm and mixture of clay, bagasse and perlite in the different ratios with required amount of water for plasticity. Green samples' moisture content removed at atmospheric temperature until the reduction of water content. Sun-dried specimens were fired in laboratory induction furnace at the rate of $4.5^oC/m$ until 800^0C. Final cured product was tested for evaluation of different properties i.e. Thermal conductivity, compressive strength, SEM-EDS and TGA.

The results show that an increasing quantity of the bagasse and perlite in the clay mixture significantly decrease the thermal conductivity of clay brick, and a small reduction in compressive strength was observed.

KEYWORDS: Bagasse, perlite, SEM-EDS & TGA

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Original Article

INTRODUCTION

Worthwhile ontogenesis has prominence through, as long as permutation in the metrological character and depletion are collateral. This embarrassment is complimented by scholarly upgrading within the building construction sector, and lives with provincial focus on the energy saving of buildings to create some worthwhile surroundings. The straight enhancing of expert energy saving of buildings is enhanced by the thermal insulation properties of the construction dwellings. Thermally active components and the morphology of the building material are fateful factors for rating heat transformation in materials. Thermal property of materials is meticulously related to composing materials and its morphology. Thermal well-being and energy saving are universal concerns, which needs much consideration within the construction materials manufacturing [1].

The world economy growth depends upon the effective use of renewable energy sources and reuse of industrial residuals. Energy saving also is one of the important roles to improve the economy of a country [2]. A

study reported that in buildings, heat management is one of the important roles, so thermal insulating materials production cost might be low due to addition of suitable industrial waste i.e. that have insulating properties, and it can reduce the environmental pollution released from industries [3]. Presently, thermal insulation materials production from the glass fibre is procured from the silicon sources and other synthetic fibres that are developed from petroleum-based resources. Synthetic based materials have ability to damage the genome [4]. Due to effective utilization of an industrial waste, it would be facilitating to decrease the industrial waste, environmental pollution and also intend to improve the economy [5]. Perlite consists huge amount of thermal insulating properties, so it is used for thermal insulation of the buildings and acts as binder material in the building constructions i.e. clay and cement-based bricks [6]. Conforming to a study on perlite and clay brick-based bricks, percentage of perlite is more aggregate and provided better results in terms of light weight and durability of bricks [7]. Perlite consists of better binding properties with clay, so it facilitates to manufacturing of fine product [8]. Current report on humidity intermediary by permeable material in an interior design of buildings and better performance is provide from bentonite, admixed with perlite [9]. Sugarcane bagasse is a residue generated from crushing mills that has low pozzolanic reactivity due high porosity. The bagasse generated by sugar industry accumulate every year, generating a series of negative consequences for the both human health and the environment. In addition, this is a waste of a potential source of products.

Different reports on clay admixture with perlite and fibers provided better properties like; reduction of heat flow, decrease in weight and load resistance [11, 12]. In this study; clay, perlite and bagasse are used to produce thermal insulation fired clay bricks. The thermal and mechanical properties of obtained fired clay bricks are investigated.

EXPERIMENTAL PROCEDURE

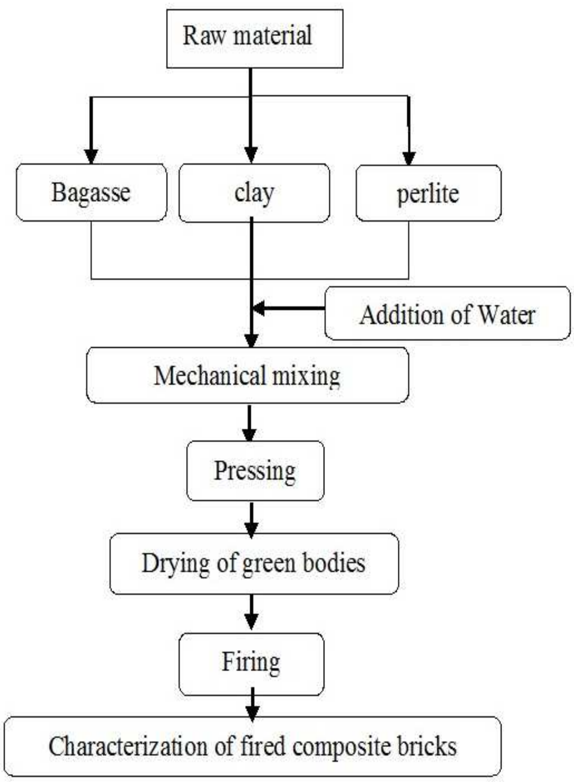


Figure1: Flow Chart for Experimental Procedure

PROCEDURE FOR CLAY BRICK PREPARATION

Brick raw materials i.e. clay, Perlite and Bagasse were dried at atmospheric temperature, after heated in woven for final cure. Dried raw materials were powdered by mechanical grinders. Prepared bagasse and perlite blended with fine clay were centrifuged by mixing up to 850rpm for 40 min. These mixtures were compacted by manual force for rectangular shaped specimens (150 x100 x 50 mm). The prepared samples were dried at atmospheric temperature. Dried specimens were fired in laboratory induction furnace at the rate of 4.5^{o}C/m until 800^{o}C. Fired samples were characterized to estimate mechanical behaviour like compressive strength, and morphology, element chemical composition by SEM-EDS analysis and Temperature vs. Weight change by the TGA.

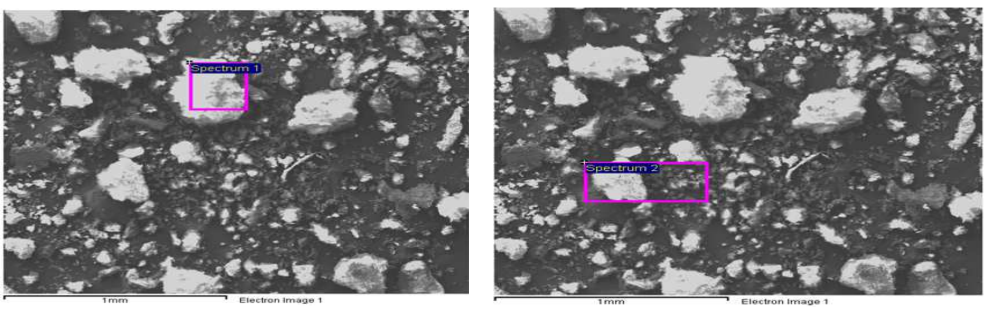
Figure2: Procedure for Clay Brick Preparation

RESULTS AND DISCUSSIONS

Characterization of Brick Raw Materials

Morphology and microanalysis of the raw materials i.e. clay, bagasse and perlite are shown in Figures 2, 3 & 4. Also, the fired clay samples were analysed by SEM/EDS. The clay samples were studied with a model S3400Analytical Scanning Electron Microscope. Particle images were obtained with a secondary electron detector. The SEM/EDS micrograph of the prepared clay samples are shown in Figure 5. The received bagasse from sugar industry had about some percentage of moisture content (50%). In Figure 2, the SEM image of clay powder has been shown. According to SEM-EDS analysis, this clay essentially consists of Si and Fe along with some K, Ca, Mg, and Al. In Figure 3, the SEM image of the bagasse has been shown. According to SEM-EDS analysis, bagasse consists C (53.25weight %) and O (46.75weight %). Likewise in figure 4, the SEM images of the perlite are shown. According to SEM-EDS analysis, perlite consist rich amount of O, Si along with some Na, Al and K.

SEM-EDS Analysis of Bagasse



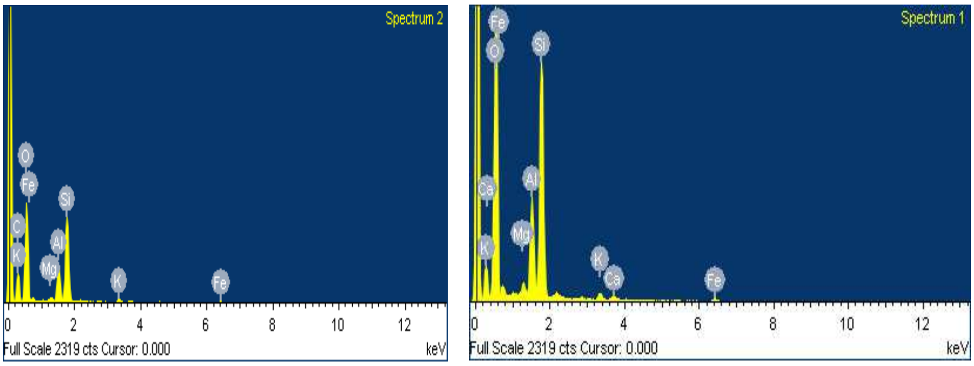


Figure 3: SEM-EDS of Raw Clay

SEM-EDS Analysis of Raw Clay

Table1: Chemical Analysis of Raw Clay

Spectrum-1	**Element**	**O**	**Mg**	**Al**	**Si**	**K**	**Ca**	**Fe**
	Weight %	50.06	0.99	9.01	26.35	1.79	1.79	10.01
	Atomic %	66.87	0.86	7.06	19.82	0.97	0.63	3.79
Spectrum-2	**Element**	**C**	**O**	**Mg**	**Al**	**Si**	**K**	**Fe**
	Weight %	16.73	43.65	0.74	7.57	21.9	2.01	7.39
	Atomic %	25.81	50.56	0.57	5.2	14.45	0.95	2.45

SEM-EDS Analysis of Bagasse

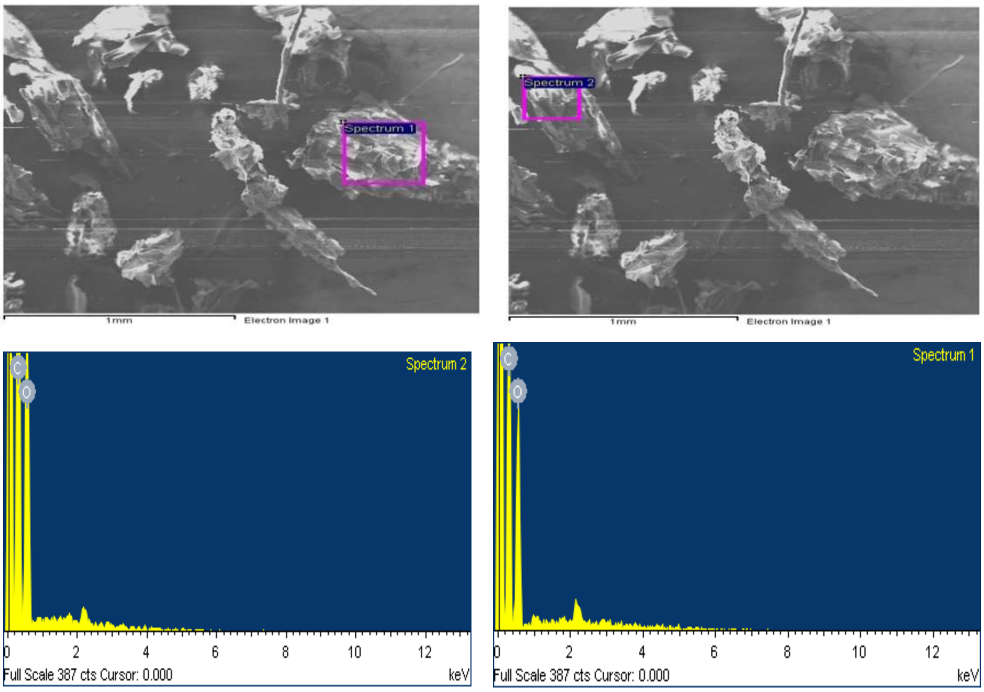


Figure 4: SEM-EDS Images of Bagasse

Table2: Chemical Analysis of Bagasse

Spectrum	**Element**	**C**	**O**
Spectrum-1	**Weight %**	53.25	46.75
	Atomic %	60.27	39.73
Spectrum-2	**Weight %**	58.83	41.17
	Atomic %	65.56	34.44

SEM-EDS Analysis of Perlite

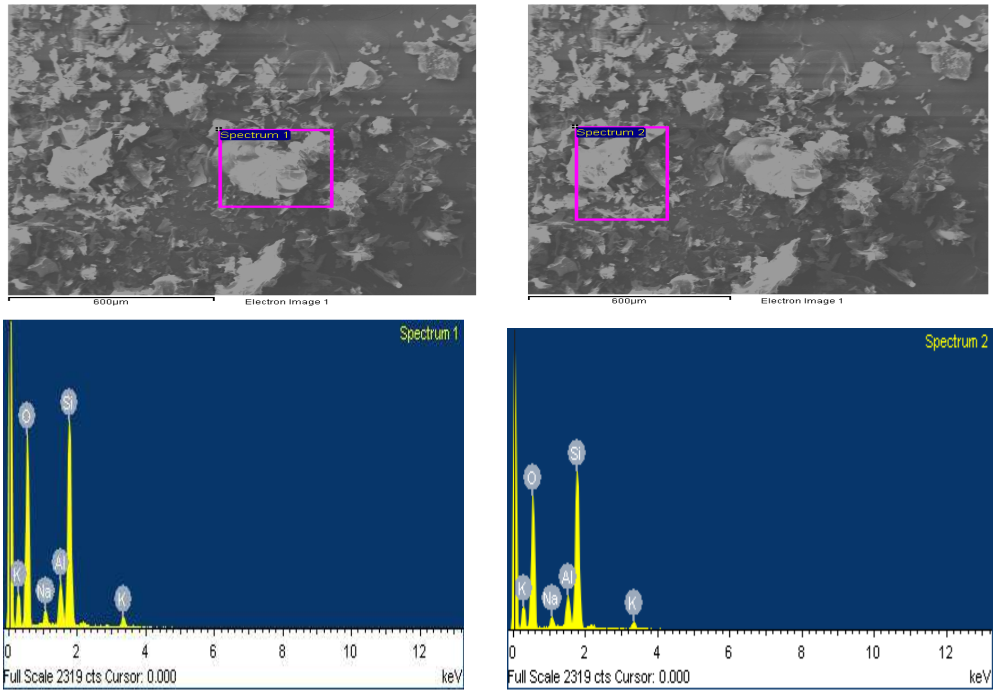


Figure 5: SEM-EDS Images of Perlite

Table 3: Chemical Analysis of Perlite

Spectrum	Element	O	Na	Al	Si	K
Spectrum-1	**Weight %**	52.63	2	6.23	34.61	4.53
	Atomic %	66.38	1.78	4.66	24.86	4.53
Spectrum-2	**Weight %**	51.25	2.23	6.05	36.39	4.07
	Atomic %	65.05	1.95	4.56	26.31	2.12
Spectrum-3	**Weight %**	49.81	2.12	7.47	36.95	3.65
	Atomic %	63.65	1.82	5.66	26.9	1.91

SEM-EDS for all samples

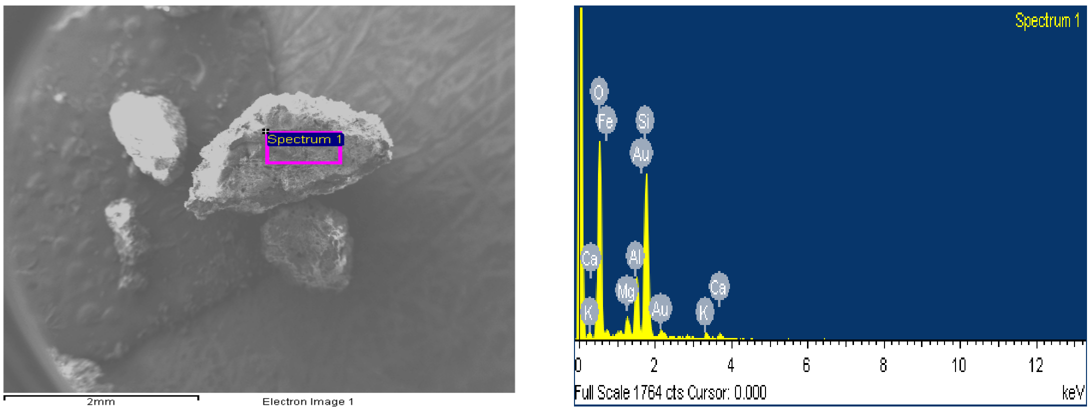


Figure 6: SEM-EDS of Sample 1

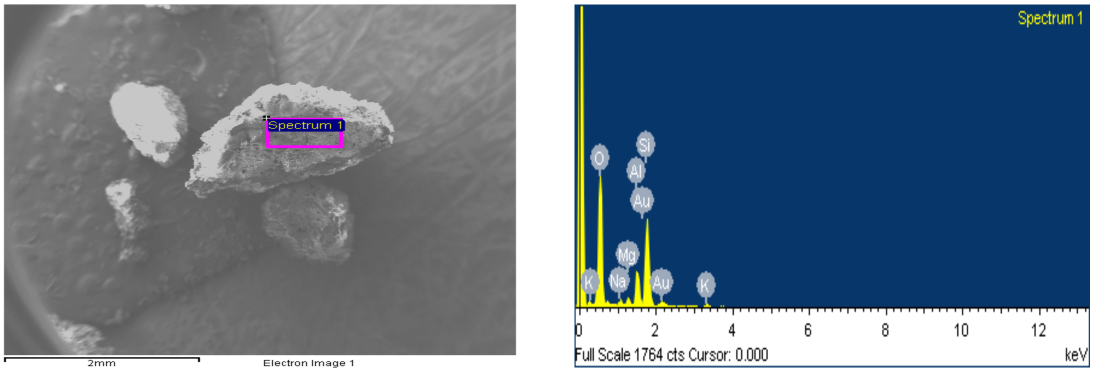


Figure 6: SEM-EDS of Sample 2

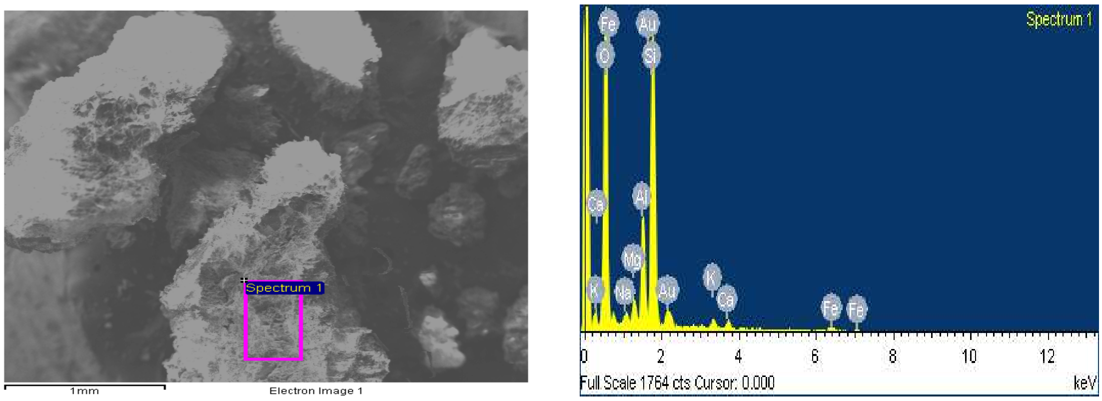


Figure 6: SEM-EDS of Sample 3

Table5: Chemical Analysis of All Samples

S-1	**Element**	**O**	**Na**	**Mg**	**Al**	**Si**	**K**	**Ca**	**Fe**	**Au**
	W %	45.04	0.58	1.53	7.58	26.86	1.94	2.56	7.41	6.49
	A %	63.69	0.57	1.42	6.36	21.64	1.12	1.44	3.00	6.75
S-2	**Element**	**O**	**Na**	**Mg**	**Al**	**Si**	**K**	**Au**	**-**	**-**
	W%	55.72	1.25	1.44	8.16	25.02	1.79	6.64	-	-
	A%	71.53	1.12	1.21	6.21	18.30	0.94	0.69	-	-
S-3	**Element**	**O**	**Mg**	**Al**	**Si**	**K**	**Ca**	**Fe**	**Au**	**-**
	W %	45.81	2.41	7.54	24.63	2.12	2.51	9.66	5.32	-
	A %	64.55	2.24	6.30	19.77	1.22	1.41	3.90	0.61	-

TG ANALYSIS

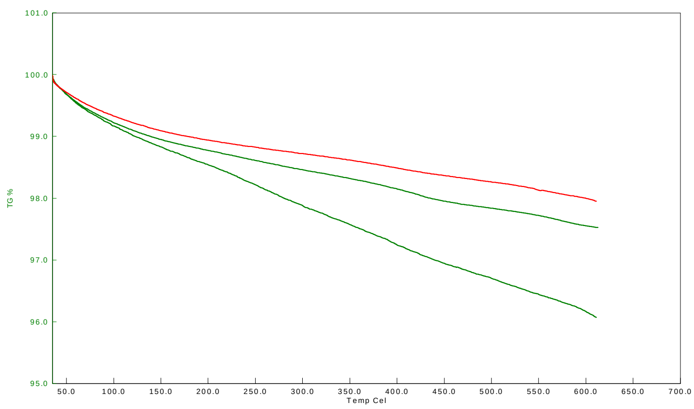
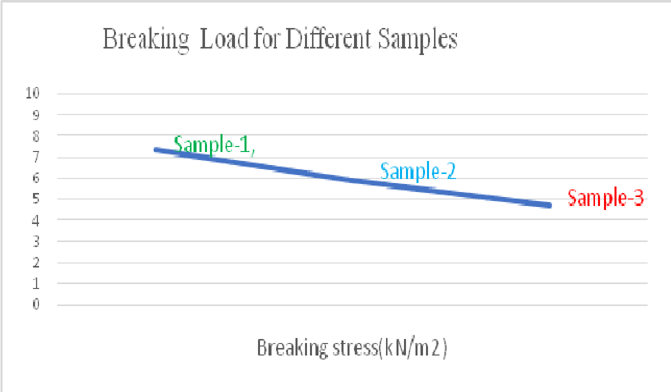


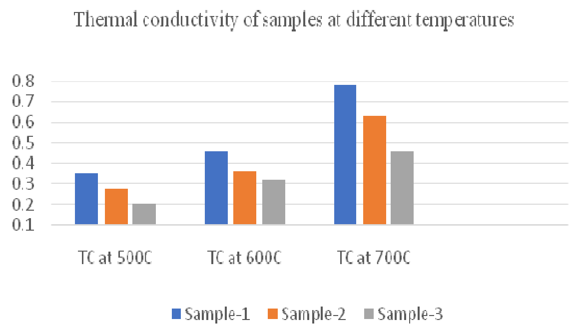
Figure 7: TG Analysis of Samples

Thermal behaviour of samples was evaluated by using SICO62Nano for TGA type of instrument. Sample-I accurately consist 9.031mg weight, and it was heated at 19^0C/min under nitrogen purge stream up to 700^0C. Figure7 bottom line shows the total weight loss 2.5%, as observed in the 150–620^0C temperature range. Sample-2 consist 3.975 mg weight in the above graph and the mid line indicates the total weight loss as 3.9%, at the 100-610^0C temperature range. Sample-3 consist 10.024 mg weight, in the above graph, up line indicates the total weight loss as 2.0%, at the 90-605^0C temperature range. Compressive strength details are presented in the above graph 1. Sample -1 consist 10% (added by weight basis) bagasse and perlite remained clay, sample-2 consist15% bagasse, 20% perlite and remained clay and sample-3 consist 20% bagasse,30% perlite remained clay. Due to increase in the bagasse and perlite percentage, brick compressive strength decreases, sample-1 and sample-2 provide permissible compressive strength.



Graph 1: Breaking Stress of Sample

Thermal conductivity values of the samples was evaluated by hot disk apparatus and represented in the graph blow (graph 2). Sample -1, 2 and 3 provide low thermal conductivity values at 500^0C, and sample-2 had high value when compared with the remaining samples. At 600^0C, sample-1 provides high thermal conductivity compare with remaining samples. At 700^0C, sample provide high thermal conductivity than remaining samples, sample-3 provides high thermal resistance, because it consists major portion of bagasse and perlite.



Graph 2: Thermal Conductivity of Samples

CONCLUSIONS

In this paper, results of the study on the industrial waste, bagasse from sugar industry and perlite from siliceous volcanic rock admixed with a clay product is presented. The results show that little shrinkage of 1.75 percentage occurred in the brick that contained bagasse and perlite, while the brick without bagasse and perlite shrunk by about 2.7 percentage. Samples' fired densities varied between 2.07 and 1.77 g/cm3, which are compatible with the decrease of 28%, when

compared to the density of the brick, without bagasse and perlite. Water absorption values were increased with increase in the content of bagasse and perlite addition. Samples' porosity increases due to the addition of perlite and bagasse content. So, the compressive strength of the samples decreased. Compressive strength of the samples was still higher than the standard strength values. Samples' thermal conductivity values varied, according to addition of bagasse and perlite because, perlite consist huge amount of Al_2O_3 and SiO_2. Preparatory results on sugar industrial wastes i.e. bagasse and perlite indicated prosperous production of thermal insulated composite clay bricks.

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